Chemical & Engineering NEWS
September 20, 1982

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The fight to survive

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Cover: Workers help load fuel into reactor core at Florida Power & Light's St. Lucie Unit One in St. Lucie County. Photo courtesy of Atomic Industrial Forum

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Troubled nuclear power tries to recover

Even if the industry can overcome its present problems, which range from construction delays, slowing electricity demand, and huge capital costs to public disenchantment, its outlook is hazy at best

Earl V. Anderson
C&EN, New York

Ask if the nuclear power industry has a future and the answer is a simple, straightforward yes.

Ask what kind of a future the industry has and that's when the answer is hazy at best.

Nuclear power has been in trouble—deep trouble—for the past several years. There hasn't been a nuclear reactor ordered since 1978. Far too many, from the industry's point of view, of those that had been ordered have been canceled. Even some that were in advanced stages of construction have been scratched.

Delays and deferrals are commonplace and, as a result, once-ambitious construction schedules are slipping further and further behind targeted on-line dates.

Cost overruns are getting out of hand. Utilities, the customers of nuclear reactor builders, are in deep financial trouble. Unless they are able to get out of their financial bind—and that will be a Herculean task—even more cancellations, deferrals, and delays in nuclear power plant construction are inevitable.

"Streamlining the regulatory process" is still a cliché that has more symbol than substance. Regulations governing nuclear power, although getting better, still are cumbersome, slow, and costly. Yet, with the rash of safety-related problems that have come to light in the past few years, it is unreasonable for the industry to expect too much too soon in the line of regulatory reform.

Public acceptance of nuclear power is much less than enthusiastic, especially since Three Mile Island. And, although there may be some justification to arguments that public fears are more perceived than real, those fears are there nonetheless.

A major reason for public disenchantment with nuclear power is that, after all the years of commercial nuclear power plant operation, there still is no firm solution to the problem of nuclear waste disposal. Technically, safe nuclear waste disposal is possible and has been for some time. But the political minefield has been impassable for a sound nuclear waste disposal policy.

On top of all this, demand for the product of nuclear power plants isn't what it used to be. These plants produce electricity, and the once-attractive growth rate in demand for electricity has slowed to a trickle. Although electricity demand growth likely will pick up again, it never will regain the hefty rates of the late 1960s and early 1970s that spawned dreams of a 1000-giga electron volt nuclear power output by the year 2000.

Taken together, this roll call of problems would spell trouble for any industry. It has spelled exactly that for nuclear power.

Pessimists about the future of nuclear power, at least in the U.S., are a dime a dozen. At a meeting in Ithaca, N.Y., earlier this year, John F. Ahearne, one of the five commissioners at the Nuclear Regulatory Commission (NRC), said, "We are here today in what could be called a wake for nuclear power."

Many other nuclear observers echo these sentiments. "There is no industry to speak of anymore," says one. "There is no recovery in sight," says another.

But optimists are not yet an endangered species. One optimist is Carl Walske. He has to be. He is president of the Atomic Industrial Forum, the industry's trade association. Walske calls himself "a holdover from the Mickey Rooney-Judy Garland movies where the kids could put on their show and save pop's store."

That is an appropriate analogy. Indeed, the nuclear store is threatened by a flock of villains—most of them economic. And all nuclear proponents have going for them is the hope that they can keep the villains at bay long enough for economic conditions to improve. Supporting this hope is one overriding factor: If the economy is to improve, more electrical power will be necessary. With oil and natural gas pricing themselves

New plants will boost nuclear power capacity

Number of reactors	Boiling-water reactor	Pressurized-water reactor	Other[a]	Total	Capacity (MW)
Operating or licensed	**25**	**48**	**3**	**76**	**58,495**
In full power	24	45	3	72	55,061
In power ascension	0	2	0	2	2,328
Shut down indefinitely[b]	1	1	0	2	1,106
Construction permit granted	**26**	**49**	**0**	**75**	**83,288**
Construction at 20% or more	21	38	0	59	64,870
Construction at less than 20%	5	9	0	14	15,858
No construction	0	2	0	2	2,560
Construction permit pending	**5**	**5**	**1**	**11**	**12,714**
Order placed for new plant	**0**	**3**	**0**	**3**	**3,510**
TOTAL	**56**	**105**	**4**	**165**	**158,007**

a Includes two reactors owned by the Department of Energy (Shippingport and Hanford N), and one high-temperature gas-cooled reactor (Fort Saint Vrain), all in operation. Also includes one liquid-metal fast breeder reactor (Clinch River), for which construction is not yet authorized. b Does not include Indian Point I, shut down since 1974 (operating license withdrawn in 1980) or Humboldt Bay (future operation is questionable because of owner's recent withdrawal of application to restart). Units shut down indefinitely include Three Mile Island and Dresden I. **Note:** During the first two months of 1982, seven reactors in the above tally were canceled. These include two which had been granted construction permits, and five others for which construction permits were pending. **Source:** Department of Energy

out of the market and with the country supposedly trying to reduce its reliance on these fuels anyway, that leaves the economic future of the country squarely on the shoulders of nuclear power and coal.

But even if nuclear power can survive the troublesome present and make it to the future, that future, as one wag put it, "ain't what it used to be and never will be."

Years ago, nuclear power's future looked promising. In the late 1960s and early 1970s, when electricity demand was averaging a 7% annual growth rate and expected to continue that way indefinitely, orders for nuclear power reactors came pouring in.

In a nine-year stretch between 1966 and 1974, orders were placed for 218 reactors with a combined capacity of 224,077 MW. That's about 90% of all the nuclear power capacity ordered since civilian nuclear power began.

After that, reactor orders slowed to a trickle. In the following four years, only 13 reactors with a combined capacity of 15,232 MW were ordered. Since 1978, not a single order has been placed for a nuclear power reactor. Undoubtedly, lower electricity growth rates, a poor economy, and a financially troubled utilities industry helped trigger the drought. In addition, the fact that the worst accident in nuclear power's history—Three Mile Island—occurred in March 1979 also had to have an impact.

Order books for nuclear power reactors have shown nothing but cancellations ever since. In fact, the rush to cancel orders already placed started as far back as 1974. The stark reality is that, compared to 13 reactors ordered since 1975, 78 reactors have been canceled. Compared to 15,232 MW of nuclear power capacity that was ordered since 1975, a whopping 84,970 MW were scratched from the books.

Cancellations still are the order of the day. During the first half of the year, another eight reactors (9900 MW) were scrubbed by four utilities.

The cancellation list is certain to grow bigger. For instance, last month Tennessee Valley Authority (TVA) scrapped further construction on four partially completed nuclear power plants. Blaming dwindling electricity demand, TVA believed that it would be cheaper for its customers to cancel the units than to keep them on hold until construction was justified again.

Last month, too, Houston Lighting & Power Co. dropped its plans to build its Allens Creek nuclear power plant in Austin County, Texas. Although economics shares some of the blame, the company cited continuing delays in getting a construction permit from NRC as a primary reason. Construction had not yet begun when HLP called it quits. Yet, the company ordered Allens Creek units 1 and 2 in 1973 (and canceled unit 2 in 1976).

Many reactors that have escaped the cancellation block have run smack into another problem: delays.

According to Department of Energy (DOE) statistics, an average of 66 nuclear power plants were hit by one kind of delay or another in each of the past seven years. Over these years, the average delay was 16 months per reactor in each year.

The total slippage for the period is staggering. It amounts to a whopping 7480 months. This means that, since 1975, 89 reactor years have been lost to delays in nuclear power plant construction.

Certainly, the regulatory maze, intervenor litigation, and on-site demonstrations by antinuclear groups have contributed to these delays. But the industry itself must shoulder some of the blame. Overoptimistic construction schedules account for some delay. Labor problems and poor labor productivity also are factors. Sloppy work that had to be corrected and a host of other problems that cannot be attributed to anything but industry shortcomings have added to the delay problem.

Whatever the reasons, delays are costly. Take, for example, the Millstone 3 nuclear power plant of Northeast Utilities in Waterford, Conn. The unit, now 52% complete, originally was scheduled to go on line in 1979. Now the date is 1986.

Two years ago, Northeast estimated the plant would cost $2.6 billion. This year's estimate is $3.54 billion, a painful $940 million more.

In Missouri, Union Electric Co. says that its Callaway 1 reactor will be another year late coming on line. Now the target is late 1984 or early 1985. As a result, the company has raised the plant's estimated cost from $2.1 billion to $2.85 billion. Original price tag for Callaway 1, which was supposed to be finished next year: $1.6 billion.

This gloom-and-doom dirge, how-

Mid-1960s, early 1970s were good years for nuclear reactor orders; late 1970s were bad because of cancellations

	Total orders placed		Later canceled		Net orders[a]		Cancellations by year of cancellation	
	No. of units	Net MW	No. of units	Net MW	No. of units	Net MW	No. of units	Net MW
1953	1	60	0	0	1	60	0	0
1955	2	465	0	0	2	465	0	0
1956	1	175	0	0	1	175	0	0
1958	1	65	0	0	1	65	0	0
1959	1	72	0	0	1	72	0	0
1962	2	630	0	0	2	630	0	0
1963	5	3,018	1	462	4	2,556	0	0
1965	7	4,475	0	0	7	4,475	0	0
1966	20	16,526	0	0	20	16,526	0	0
1967	31	26,462	2	1,482	29	24,980	0	0
1968	15	14,018	1	1,115	14	12,903	0	0
1969	7	7,203	2	2,137	5	5,066	0	0
1970	14	14,264	1	583	13	13,681	0	0
1971	21	20,957	10	9,864	11	11,093	0	0
1972	38	41,313	18	19,007	20	22,306	6	5,002
1973	38	43,319	15	15,876	23	27,443	0	0
1974	34	40,015	24	27,724	10	12,291	9	9,516
1975	4	4,148	4	4,148	0	0	10	11,729
1976	3	3,804	2	2,534	1	1,270	5	5,090
1977	4	5,040	4	5,040	0	0	10	10,814
1978	2	2,240	0	0	2	2,240	11	11,287
1979	0	0	0	0	0	0	13	15,252
1980	0	0	0	0	0	0	14	15,501
1981	0	0	0	0	0	0	6	5,781
TOTAL	251	248,269	84	89,972	167	158,297	84	89,972

a Remaining orders after subtracting cancellations by year of order. **Note:** The years 1954, 1957, 1960, 1961, and 1964 are omitted because there were no orders nor cancellations. **Source:** Department of Energy

ever, masks the fact that there is a big slug of nuclear-generated capacity now operating in the U.S. and contributing significantly to the country's electricity supply. AIF's latest scorecard (midyear) shows 81 reactors with operating licenses and a combined capacity of 62,705 MW.

In reality, only 73 reactors (56,196 MW) are in commercial operation. Three others have low-power operating licenses, Pacific Gas & Electric's Diablo Canyon 1 in California has had its low-power operating license suspended, and four reactors have been shut down indefinitely.

Still, nuclear power plants accounted for 12% of U.S. electricity output last year. In some regions, nuclear's share is much higher, particularly in the eastern and central portions of the country. In New England, for instance, nuclear power contributed 33.5% of all electricity generated last year.

In his midyear outlook for the industry, AIF's Walske says that if nuclear power maintains its present momentum, it could land in second place this year as a source of electricity behind coal, which supplies more than half of the total.

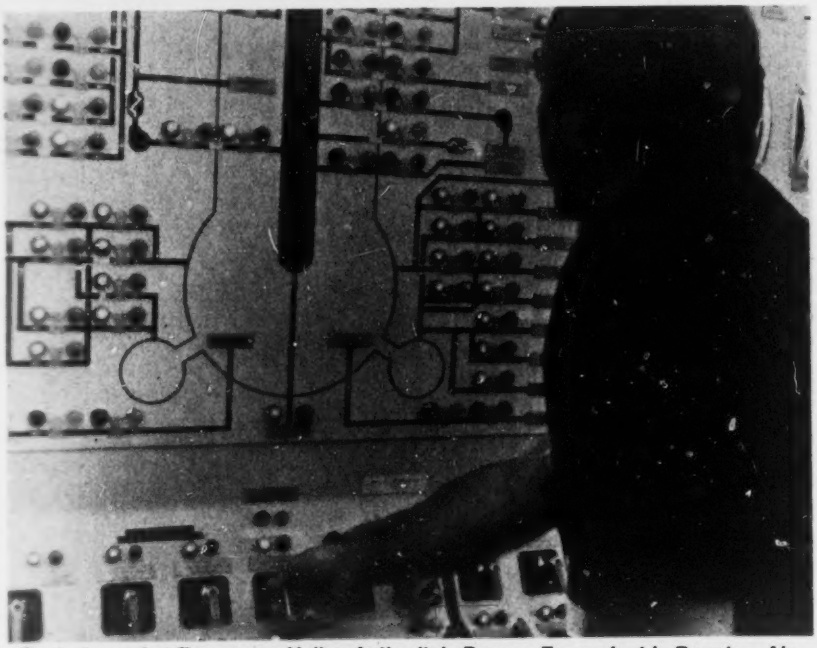
That may be asking a lot of nuclear power. DOE's Energy Information Administration estimates that nuclear power this year will generate 313 billion kWh of electricity. That's a nifty 15% increase, but still only good enough to account for 13% of total electricity output. Unless something drastic happens to natural gas, which has held second place for many years with about a 15% share, nuclear power will retain its still-respectable third spot in 1982.

Next year, however, may be nuclear's year for the runnerup position. In 1983, another 10 or 11 nuclear power plants (depending on the amount of delay encountered) are expected to come on line. These units will add between 10,000 and 11,000 MW to total U.S. nuclear capacity.

In addition to those reactors with operating licenses, AIF tallies an additional 77 reactors in the pipeline; 69 of them have construction permits, and another eight reactors are on order.

If its yearly schedule of additions is correct, AIF says that, by 1990, there will be 137 nuclear power plants in the U.S. with a total capacity of 122,512 MW. That's both encouraging and disappointing to the industry.

It's encouraging because it means that nuclear power capacity will double in just eight years. That's more than most elements of the economy will be able to say. But compared to the 251 units and 248,000 MW that were, at one time, on order, it's very discouraging.



Control panel at Tennessee Valley Authority's Browns Ferry plant in Decatur, Ala.

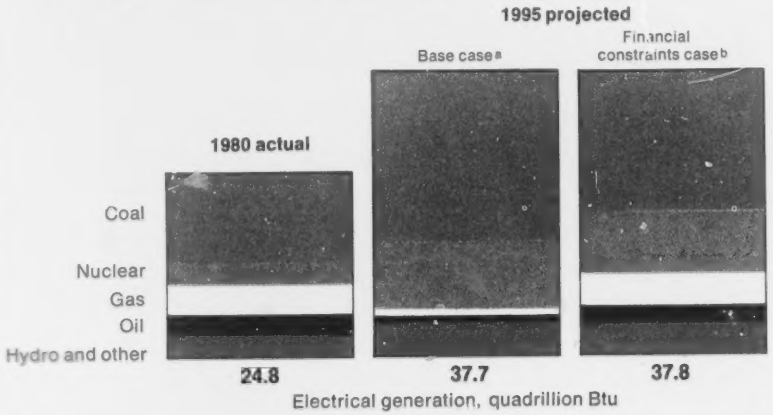
It's also possible—probable is more like it—that some of these units will fall victim to the cancellation ax. At least 17 nuclear power plants still are less than 25% complete.

Recent cancellations involved several units that were along in construction. Washington Public Power Supply System's plant 4 was more than 15% complete when construction was halted earlier this year.

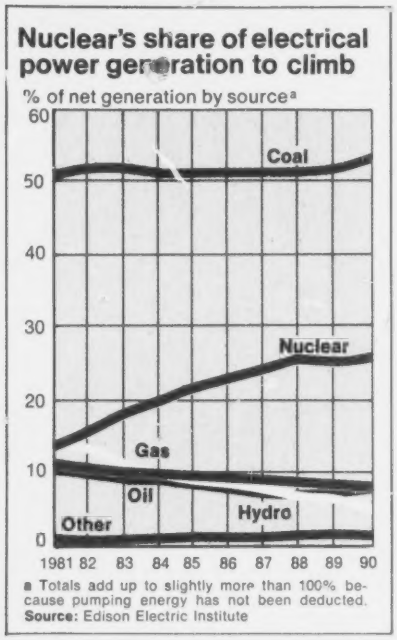
How many nuclear power plants in the pipeline actually will be completed depends primarily on the utilities. If current projections for a 3%-per-year growth rate for electricity demand prove accurate, utilities will have to invest an estimated $365 billion (1981 dollars) by 1990.

But the utility industry is a financial basket case. Once the bluest of blue chips, utility stocks and bonds have lost their luster.

Utilities' financial plight could mean more oil and gas consumption, less coal and nuclear



a Utilities able to obtain financing for all new construction currently planned and additional power plants justified by economics. b Utilities unable to obtain financing for many new projects and are able to build only those units for which they already have a major financial commitment. Under these conditions, utilities build only about 50% of coal power plants currently under construction or planned and about 80% of nuclear power plants under construction or with a construction permit. **Source:** Department of Energy



Utilities, because they are highly capital intensive, have been hit particularly hard by inflation and high interest rates. Nuclear power plants are especially capital intensive.

According to DOE, real construction costs have jumped 100% between 1971 and 1980. And it estimates that construction costs for plants coming on line in 1995 could increase another 60 to 100% in constant 1980 dollars.

Today, it's not unusual for a large nuclear unit to cost up to $3000 per kW of capacity. By comparison, plants already operating are in the $400- to $500-per-kW range.

To make matters worse for the utilities, public utility commissions normally don't allow them to increase rates until the new unit actually is generating electricity. The reason: They don't think that customers should pay for something that they don't yet have. As a result, utilities must finance new construction by selling stocks and borrowing.

When power plants were smaller, less expensive, and quicker to build, utilities were able to handle the financial load until rate increases started flowing in. Now, however, with new plants larger, much more expensive, and taking 12 to 13 years to build, utilities find the financing burden almost unbearable.

It's not surprising, then, that utilities are going all out to reduce capital requirements as much as possible. As a result, fewer plants, both coal and nuclear, are being ordered and built. The cutback also accounts for many of the cancellations and deferrals that have taken place.

Although this strategy may ease the short-term financial problems of both the utilities and their rate-paying customers, it could signal more severe problems later for the entire economy if the link between gross national product (GNP) growth and demand for electricity holds.

This is where the uncertainty comes in for the nuclear power industry, the utilities industry, and for just about every other industry for that matter. How fast will GNP grow? How fast will demand for electricity grow?

There are no shortages of forecasts. But the disparities in forecasts of future economic, energy, and electricity growth only add to the confusion.

Supply-side Reaganomics, for instance, is predicated on the presumption that GNP will grow at an average annual rate of 4 to 5% during the 1980s. But in its latest annual report to Congress, DOE's Energy Information Administration (EIA) based its energy projections on an average GNP growth of about 2.5%.

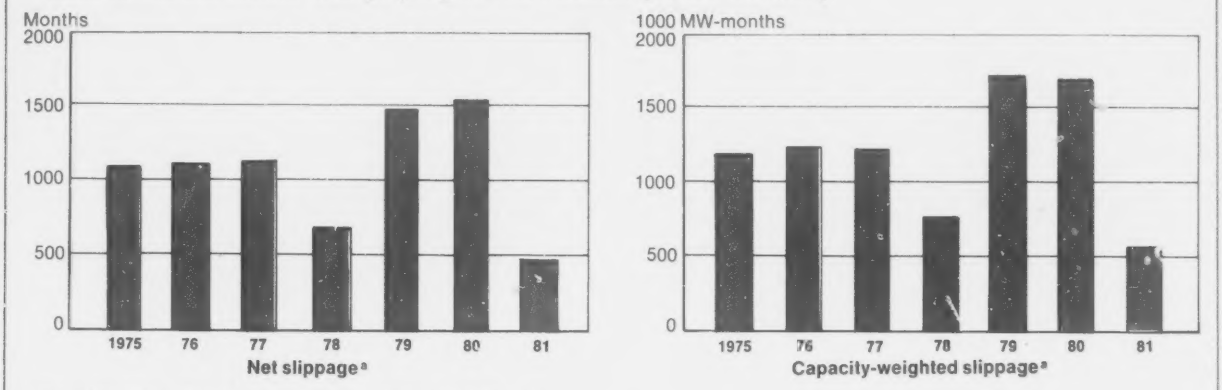
What does this mean for electricity? There is a critical relationship between the two. From the 1950s through the 1970s until the Arab oil embargo, electricity consumption grew about twice as fast as GNP. That ratio has fallen off since the

Growth in electrical output has declined, but coal and nuclear have increased their share

	Electric power generation, billions of kWh													
	Nuclear		Coal		Oil		Gas		Hydro		Other[a]			% annual change
		% of total		% of total		% of total		% of total		% of total		% of total	Total	
1960	1	0.1%	403	53.5%	46	6.1%	158	21.0%	146	19.4%	b	c	753	6.1%
1961	2	0.3	422	53.3	47	5.9	169	21.3	152	19.2	b	c	792	5.2
1962	2	0.2	450	52.8	47	5.5	184	21.6	168	19.7	b	c	852	7.6
1963	3	0.3	494	53.9	52	5.7	202	22.0	166	18.1	b	c	917	7.6
1964	3	0.3	526	53.5	57	5.8	220	22.4	177	18.0	b	c	984	7.3
1965	4	0.4	571	54.1	65	6.2	222	21.0	194	18.4	b	c	1055	7.2
1966	6	0.5	613	53.7	79	6.9	251	21.9	195	17.0	1	0.1%	1144	8.4
1967	8	0.7	630	52.0	89	7.3	265	21.8	222	18.3	1	0.1	1214	6.1
1968	13	1.0	685	51.5	104	7.8	304	22.9	222	16.8	1	0.1	1329	9.5
1969	14	1.0	706	49.0	138	9.6	333	23.1	250	17.3	1	0.1	1442	8.5
1970	22	1.5	704	47.2	184	12.0	373	24.6	248	16.6	1	0.1	1532	6.2
1971	38	2.4	713	44.2	220	13.6	374	23.2	266	16.5	1	0.1	1613	5.3
1972	54	3.1	771	44.1	274	15.6	376	21.5	273	15.6	2	0.1	1750	8.5
1973	88	4.5	848	45.6	314	16.9	341	18.3	272	14.6	2	0.1	1861	6.3
1974	114	6.1	828	44.4	301	16.1	320	17.1	301	16.1	3	0.1	1867	0.3
1975	173	9.0	853	44.5	289	15.1	300	15.6	300	15.6	3	0.2	1918	2.7
1976	191	9.4	944	46.3	320	15.7	295	14.5	284	13.9	4	0.2	2038	6.3
1977	251	11.8	985	46.4	358	16.9	306	14.4	220	10.4	4	0.2	2124	4.2
1978	276	12.5	976	44.2	365	16.5	305	13.8	280	12.7	3	0.2	2206	3.9
1979	255	11.4	1075	47.8	304	13.5	329	14.7	280	12.4	4	0.2	2247	1.9
1980	251	11.0	1162	50.8	246	10.8	346	15.1	276	12.1	6	0.2	2286	1.7
1981[d]	272	11.9	1202	52.4	206	9.0	345	15.1	261	11.4	6	0.3	2293	0.3

a Includes wood, geothermal, and waste. b Less than 0.5 billion kWh. c Less than 0.05%. d Preliminary. Source: Department of Energy

Years of construction delays plague the nuclear power industry



a Net of delays minus advances in schedules. **Source:** Department of Energy

embargo, but electricity demand still has grown an average 1.5 times faster than GNP.

To Peter Navarro, a researcher at Harvard University's Energy & Environmental Research Center, this suggests a rough rule of thumb: GNP can't grow substantially faster than growth in electricity demand. In fact, if the country expects to reduce its dependence on oil in general and imported oil in particular, the GNP-electricity linkage can grow only stronger.

That, too, is a big if for the nuclear power industry. It implies that nuclear—and coal—must play a bigger role in generation of electricity. Those are the only two logical substitutes for oil and natural gas in central power stations.

Forecasts of electricity demand also do little to help utilities make definite plans for the future. A recent sampling has 1980 to 1990 demand growth ranging from 1.6 to 4.5% per year. Most forecasts, however, zero in on 3.0 to 3.5%.

If those figures are right, GNP growth as seen through the eyes of Reaganomics will be all but impossible to realize. But a GNP growth rate of 2.5 to 3.0% annually could be achieved.

Will there be enough generating capacity in 1990 to satisfy demand for electricity? The North American Electric Reliability Council (NAERC) forecasts a 3% annual net increase in capacity in the 1980s. That's borderline to meet projected demand.

To make matters worse, NAERC also points out that more than half of the planned capacity has been delayed an average of 20 months. It's likely, too, that some proposed units will be canceled. Some already have been. It's entirely possible, then, that capacity growth will be something less than 3%, which may not be enough to meet demand. The result could be brownouts, blackouts, and not enough electricity to support industrial growth.

The only alternative is to retreat back along the path to more oil and gas, something the country wants to avoid.

A study made last year by DOE's EIA indicates what could happen. It analyzed two possible alternatives for the nation's investor-owned utilities. In one (the base case), it assumes that utilities are able to obtain financing for all new, planned construction projects and for any additional plants justified by economic conditions.

The financially constrained case assumes that many utilities are unable to obtain enough financing for many new projects. They are able to build only those plants for which they already have made a major financial commitment.

Under these conditions, utilities build only about 50% of the coal-fired plants now planned or under construction and about 80% of nuclear power plants under construction or with a construction permit.

The study concludes that, if electricity demand increases 3.2% per year through 1995, many coal-fired and nuclear-powered plants could be delayed under the base case. But to do that, additional combustion turbines will have to be installed to guarantee regional and national reliability (an average national reserve margin of 23%). This reserve margin will have to be much higher in some regions.

If financial restraints still plague utilities, they will have to rely on much more oil and natural gas to meet electricity demand. In 1995, oil's share of total electricity generation will jump from 0.8% under the base case to 6.1%. For natural gas, the figures are 2.4% and 10.8%, respectively.

Nuclear and coal, of course, will be the big losers. Instead of generating 24.1% of all electricity in 1995, nuclear will generate only 21.7%. Coal will slip badly, from 61.5% to 52.4%.

If utilities can't break their financial chains, oil imports in 1995 will be 800,000 barrels per day higher than they otherwise would be. That's a deplorable 23.5% increase. Prices that consumers pay for their electricity will be 8% higher as a national average. But in some regions, the bills will be 24% higher.

Thus, if financing problems prevent utilities from building the more economical coal-fired and nuclear plants, not only will oil imports and fuel bills increase, but the country will lose an opportunity to eliminate about 82% of the oil and natural gas that utilities now use.

EIA's study doesn't include what may happen after 1995. But, with the long lead times that are necessary for coal-fired plants (seven to 10 years) and nuclear plants (11 to 13 years), continued delays and cancellations imply that there may not be enough capacity to meet demand after 1995, even with the addition of combustion turbines.

Suppose, though, that the utilities are able to overcome their financial problems and that they do start ordering large, efficient generating units again. Will they order nuclear, or will they order coal?

Many an argument has been triggered on the subject of which fuel generates the least expensive electricity. Basically, capital costs are

Future nuclear vs. coal generating costs depend on location

Comparative bus-bar costs, mills per kWh[a]

Region	Nuclear	Coal
I	43.0	46.8
II	45.0	44.1
III	41.9	41.1
IV	40.6	44.1
V	43.5	42.4
VI	40.6	29.5
VII	42.5	42.9
VIII	42.3	31.0
IX	44.8	44.8
X	44.8	46.5

a In 1980 dollars over 30-year plant life.

Note: For plants coming on line in 1995. Advantage implies that one plant type has a cost differential greater than 5% over the other plant type. If cost differentials are less than 5%, both plant types are considered economic choices. **Source:** Department of Energy

much higher for nuclear plants than for coal-fired plants. But, compared to coal, nuclear fuel costs are extremely small. On these two points, there is no argument.

It is how many other factors are pumped into or left out of the equation that leads to controversy. The problem is such that, in a recent DOE study on comparative costs, it offered a guideline and a methodology for doing economic analysis, particularly of nuclear- and coal-powered generation.

One of the most publicized pro-coal studies was prepared by Charles Komanoff of Komanoff Energy Associates. He predicts that future nuclear power plants will cost so much more than coal-fired plants that their "lifetime generating costs will exceed those of new coal plants by 20 to 25% on average."

He also claims that Three Mile Island-related costs will drive the difference to 35 to 50%. "Many reactors under construction could be scrapped with little or no economic penalty," says Komanoff.

The nuclear industry, the utilities, most independent consultants, and a string of government studies disagree. "If Komanoff is right, then obviously there is no future for the nuclear industry, and a lot of other things, too," says one critic of the Komanoff study.

A major complaint about the study is its choice of capacity factors. Capacity factor, a key gauge in power plant performance, is the ratio of kilowatt-hours a plant actually produces to what it could have generated running 24 hours a day each day of the year. The higher the number, the better the performance.

Selecting the proper capacity factor is important. New power plants, both coal and nuclear, are expensive. Carrying charges on invested capital will dominate electric power generating costs.

A low factor spreads annual carrying charges over fewer kilowatt-hours and raises generating costs. Komanoff assumes a 60% capacity factor for nuclear and a 70% factor for coal. According to A. David Rossin, director of research at Commonwealth Edison (Chicago), experience points the other way.

Average capacity factors for all U.S. nuclear power plants were 62.4% in 1977 and 65.2% in 1978. They dipped below 60% in 1979 and 1980, but that was in the aftermath of Three Mile Island. Some nuclear proponents say that nuclear capacity factors could be as high as 70%.

Nuclear advocates have plenty of studies to choose from that prove nuclear's cost advantage over coal. A recent one comes out of Sargent & Lundy Engineers (Chicago). The company, which designs both coal and nuclear plants, has conducted similar studies in the past and consistently has found lifetime levelized nuclear generating costs to be lower than those of coal.

In this year's study, William W. Brandfon, associate head of Sargent & Lundy's analytical division, says that nuclear has a 4.7% edge over high-sulfur coal and a 13% edge over low-sulfur coal. This study uses a 60% capacity factor for both coal and nuclear plants.

Even the staunchest nuclear advocate concedes that, as nuclear plant costs escalate, their cost advantage over coal-fired plants narrows. However, they are quick to add that large, coal-fired plants aren't immune to cost-escalation either.

A new report issued just last month by EIA may take some of the wind out of both sides' sails.

The study analyzes the relative economic merit of nuclear vs. coal-fired electricity generation for new plants beginning baseload service in 1995. Not a bad choice of years, because it would take almost until then to bring a new nuclear unit on line if the investment decision were made today.

EIA has come up with comparative levelized bus-bar costs over a 30-year plant life. Its conclusion: a tossup.

The agency concludes that, as a national average, nuclear-generated electricity would cost 42.9 mills per kWh and coal-based power would cost 41.3 mills per kWh. The advantage falls to coal, but it's really too close to call.

More important are regional cost variations, the result of differences in labor and material costs, coal characteristics, and transportation distances and costs.

Coal has a distinct advantage in the

North Central and Southwest regions, primarily because of very low projected coal costs in these regions. Nuclear also has an edge in two regions—the South Atlantic region and New England for exactly the opposite reason. In the six remaining regions, both types of plants are equally economic. EIA defines a plant as having an advantage only if it has a 5% or greater edge in generating costs.

Another important conclusion of EIA's report is that in no region of the country are oil- and gas-fired plants economic alternatives to nuclear and coal.

What all of this adds up to is what really has been taken for granted all along: Both nuclear and coal-fired power plants will be needed in the future, one more so than the other in some regions of the country.

Some antinuclear forces can and do argue for the all-coal route. Theoretically, that is possible. It's not very practical, however. Logistics alone work against it. Mining and transporting all of the coal that would be required would be a huge task. Environmental problems would escalate. Besides, as one observer put it, "Competition is good for the soul—and for power plant customers."

It's easy to see why AIF's Walske says that three of nuclear power's biggest problems are "money, money, and money." Financial aspects are, of course, very important, but the industry cannot escape the fact that it has several other headaches to overcome, too.

Nuclear power is, after all, not only an economic animal, but a political and emotional animal as well.

Just how political nuclear power can be became apparent during the Carter Administration. That Administration, unlike its predecessors, never firmly committed itself to the nuclear option. President Carter publicly described it as the "technology of last resort," fought the antiproliferation fight, and banned nuclear fuel reprocessing.

With the election of President Reagan, the political winds changed. The Reagan Administration enthusiastically endorses nuclear power and breeder technology coupled with reprocessing of spent nuclear fuel.

The Administration's commitment to regulatory reform also is apparent at NRC. The industry places much of the blame for its plight squarely on a labyrinthine regulatory process. Some of that blame undoubtedly is deserved; some of it isn't.

Under the leadership of chairman Nunzio J. Palladino, a determined effort is under way at NRC to revamp the power reactor licensing process and to propose legislation for one-step licensing of standardized plants.

Commissioner Victor Gilinsky has some reservations about all of this. Granting that some regulatory reform is long overdue, he nevertheless wonders about priorities. He senses a new mood among NRC staffers.

"Some of the very same senior NRC officials who were outdoing each other three years ago in proposing new safety requirements now are competing to eliminate such requirements," he says. And he wonders about the possibility that any NRC office that proposes new requirements for licenses may have to submit a detailed cost-benefit analysis along with it.

Nevertheless, regulatory reform is under way at NRC, reform that could affect both plants already under review and new license applications.

For plants already under review, possible changes in hearings formats are getting a lot of attention at NRC. Safety goals, along with numerical guidelines and wider use of probabilistic risk assessment techniques, are being reviewed.

For new license applications, an NRC task force is preparing a legislative proposal that would encourage completely standardized plants. Such an approach conceivably could improve the licensing process because both the nuclear industry and its regulators could concentrate on only a few plant designs.

This legislative effort visualizes giving NRC the authority to approve standardized plants independently, even before a company makes a specific application to build one. Any approved design would have a time limit on it. The thinking now is about five to 10 years. Thus, industry still will have an incentive to come up with new, improved designs.

Another part of the standardized plant package is preselected siting. NRC could approve a site for one or more nuclear power plants, again before an application to build a plant there is even made.

Potentially more important is a proposal that would enable NRC to issue a combined construction permit and operating license. These now require two separate regulatory procedures.

Industry also has complained long and loud about the flood of backfitting requirements that pour out of NRC, especially since Three Mile Island. The Administration wants to limit demands for backfits and, at NRC, its new Committee for Review of Generic Requirements (CRGR) may push it in that direction.

Industry feels that NRC has a tendency to order backfits only because they offer some safety improvement, even when there is absolutely no doubt about a plant's present safety level. And many experts are skeptical that CRGR will be enough to solve the backfit problem. They think that Congressional action on licensing reform may be needed.

NRC chairman Palladino says that with standardization, early siting, and combined action on construction

Reprocessing spent nuclear fuel has fresh boost from Reagan Administration

permits and operating licenses, many of the regulatory problems that have made nuclear plant construction so costly and time-consuming will be solved.

The nuclear community is not all that sure. It concedes that NRC has made improvements in the regulatory process. But it still is not certain that those improvements will help reduce runaway costs or spur a revival of new orders. And it continues to see stability in the regulatory process as a distant goal.

Commissioner Gilinsky thinks that this emphasis on licensing reform for future nuclear reactors makes little sense. "What good is it," he asks, "if there are no new orders?" He believes that both regulators and industry should be concentrating on plants now operating and those under construction.

According to Gilinsky, plants that are almost complete may not go into operation on schedule, not because of regulatory delays, but because they haven't been built right. Diablo Canyon's well-publicized seismic design problem is only one example. There are others.

Even in operating plants, there are safety-related problems. Embrittlement, one of NRC's high-priority, but unresolved issues, is one of them. Old reactor vessels subjected to certain conditions of high pressure and rapid cooling could rupture and release radioactive material into the containment building. Core meltdown is a possibility.

Steam generator problems are attracting much attention, especially since a steam generator tube ruptured and released small amounts of radioactive steam at the Robert E. Ginna plant in Ontario, N.Y. Most steam generator problems concern corrosion and mechanically induced tube and tube-support plate damage.

Industry officials concede that these and other safety problems exist. The problems are not new, they say, only the heat of the publicity is. Most of the problems have been recognized for years and, although some of them still are unresolved, they haven't gone unattended.

Solving these problems successfully and quickly could give a big boost to the prospects of the nuclear option. Gilinsky believes the entire industry is hostage to the worst performers in it. And he doesn't think that nuclear power can stand another serious accident, even if no one is hurt. "Another Three Mile Island," says Gilinsky, "and you can kiss Wall Street financing good-bye."

There are few people in the world who haven't heard about the loss-of-coolant accident at General Public Utilities' unit 2 near Harrisburg, Pa., in March 1979. Although the reactor core was damaged severely, containment was not impaired. Once coolant flow was restored, there was no possibility of a meltdown or core rupture. Only negligible amounts of radiation were released, no more than normal background radiation levels in high-altitude cities.

The press, however, played up Three Mile Island as an impending disaster. NRC suspended licensing and didn't issue another license until August 1980, almost a year and a half later. NRC, along with Congress and the Kemeny Commission, conducted reviews of nuclear safety and licensing procedures.

To the utilities, one of the most important lessons of Three Mile Island was a lack of adequate operator training. The man-machine interface has taken on a new significance. Suppliers are paying more attention to human factors in their instrument and control design.

Less than one month after the Three Mile Island accident, the industry created the Nuclear Safety Analysis Center to investigate the accident and to provide technical advice and support on safety-related matters. The center operates as a division of Electric Power Research Institute.

The Institute of Nuclear Power Operations also was formed to focus on operational aspects of nuclear power plants. It concentrates on training, staffing procedures, and plant management.

Three Mile Island probably did more to sour nuclear power in the minds of the public than all of the antinuclear sloganeering that preceded it. Indeed, public acceptance, or lack of it, has to rank right along with financial, economic, and technical problems as a major industry concern. The industry knows this, and utilities soon may launch a public information program to woo the public back to nuclear power.

Aside from keeping its safety record clean and avoiding another major nuclear accident, nothing could do more to improve nuclear power's

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public image than to finally come to grips with a national nuclear waste management program for high-level waste. "If the antinukes lose waste, they lose the ideal albatross," says one industry official.

Although a nuclear waste disposal policy definitely is a problem for industry, it requires a government solution. The Atomic Energy Act gives the federal government exclusive responsibility for disposing of high-level wastes generated from both civilian and military reactors. DOE will handle the actual job; NRC will handle the licensing.

Technically, safe high-level waste disposal is possible and has been for years. One method is to separate and concentrate the waste by reprocessing spent fuel, convert it into a dry solid, fuse it with glass, and seal it in a metal cannister. The process also can be adopted to unreprocessed spent fuel assemblies.

Present plans call for burying the waste permanently in deep geologic formations. These formations have been stable for millions of years and are expected to remain so for millions of years more.

The holdup has been in Congress. Finally, this past April, the Senate passed, by an overwhelming 69 to 9 vote, a bill that would establish a national waste policy for the first time.

Now, it is up to the House. Four different House committees have reported out three different waste bills. Committee staffs are reconciling them into a consensus bill that will have to be acted upon by the House Rules Committee. Then a Senate-House conference will have to resolve any differences in the legislation.

If Congress is able to translate a national waste disposal policy into law, it will eliminate one of nuclear power's biggest headaches. If NRC is able to cut some of its regulatory red tape and shorten lead times, it will eliminate another one.

These are two big "ifs." Meanwhile, it is industry alone that must compile a spotless safety record and restore public confidence. Some say it can't be done. The industry believes it already has rolled up a good safety record, but it can't afford to rest upon whatever laurels it thinks it has.

The nuclear power industry also must do whatever it can to overcome cost escalation and financing problems. But in the final analysis, nothing will do more for the revival—indeed, the survival—of nuclear power than a good swift kick in the pants of the economy. □

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Slump in polyurethanes continues

1982 consumption will be the same as or below 1981 level, but producers see some improvement by the end of the year

Producers of polyurethane products are going through the same sorts of pangs that makers of most other chemicals are experiencing. In other words, poor construction and automobile markets are taking their toll on the urethanes industry.

However, at least one producer—Mobay—says there may be some hope. A survey of the industry by Mobay, the U.S. arm of West Germany's Bayer A.G., shows that demand in 1982 may be a reverse image of 1981 with slow demand at the beginning of the year and a pickup toward the end. Other suppliers to the polyurethane industry agree with this assessment, but they are not sure that demand in 1982 will equal that of 1981.

Since there are no official figures on polyurethane production or demand, either from the government or trade groups, urethane chemical producers have moved in to fill the void. In the past, Upjohn has provided a yearly survey of polyurethane demand, but did not this year. So Mobay has conducted its own survey, interviewing polyurethane producers and various end market trade groups to get its data.

Mobay's survey indicates that U.S. consumption of flexible polyurethane foams in 1981 totaled 1.15 billion lb, a decrease of 3.4% from 1980. 1980 had been down 13.5% from the peak year of 1979, when demand for flexible foams totaled 1.38 billion lb.

The drop for flexible foam was led on a percentage basis by small-volume packaging applications, which fell 10.3% in 1981 (to 26 million lb) from 1980.

The largest uses of flexible foams had smaller percentage drops. Furniture applications, the biggest, fell 3.0% to 479 million lb last year. And use of flexible foams in the transportation industry dropped 4.2% to 277 million lb in 1981 from the year before.

Demand for rigid polyurethane foams, according to the survey, increased 3.1% in 1981 to 561 million lb, thus doing much better than flexible foams. In 1981, consumption of rigid foams had dropped 4.1% from 567 million lb in 1979. The biggest use of rigid foams, construction, increased 0.6% in 1981 to 321 million lb. This was due partly to the strong commercial construction sector.

Additionally, the survey shows, the percentage of material spending for insulation in construction, appliances, and other markets continues to increase as builders and manufacturers strive to increase the energy efficiency of these units.

In the microcellular and noncellular area of polyurethanes, the reaction-injection-molding market was the star performer, increasing 37.9% (to 80 million lb) last year from 1980. Two other markets in this category—cast elastomers and thermoplastics—fell 4.6% and 4.9% respectively, in 1981 from 1980.

Total consumption of microcellular and noncellular polyurethanes in 1981, excluding adhesive uses, increased 10.4% to 181 million lb.

For 1982, according to the survey, consumption of polyurethanes essentially will mirror that of 1981. Although 1981 began strong and finished weak, Mobay believes that 1982 will end on an upward trend. Other urethane chemical companies agree with this assessment. However, they estimate that total consumption in 1982 will be down 5 to 10%, whereas Mobay says that consumption this year will be about the same as that for 1981.

Mobay says that over the next five years, growth of polyurethanes will be good. Flexible foam markets are relatively mature and will grow at about the same rate or slightly faster than gross national product. Rigid foam markets will grow well above that for GNP, but not so fast as they did in the 1970s, when growth was about 15% annually. Mobay says the market is beginning to mature so that 8 to 10% growth is expected.

Use of reaction-injection-molding polyurethane, according to Mobay, will grow much more rapidly. Since it is a much smaller base, however, RIM polyurethane will not account for so much volume increase as some of the slower growing, but larger-volume markets. □

Flexible foam volume is twice that of rigid foam, but has slower growth

Millions of lb	1981	1980	1979	1978	1977	1976
FLEXIBLE POLYURETHANE FOAM	**1149**	**1189**	**1375**	**1349**	**1249**	**1186**
Furniture	479	494	533	518	480	476
Transportation	277	289	390	392	360	344
Bedding	170	173	195	199	184	175
Carpet underlay	157	161	185	167	150	136
Textile	27	30	32	32	30	14
Packaging	26	29	26	26	25	19
Miscellaneous	13	13	14	15	20	22
RIGID POLYURETHANE FOAM	**561**	**544**	**567**	**492**	**417**	**362**
Construction	321	319	316	263	197	147
Tanks and pipes	42	36	44	42	39	38
Appliances	88	84	81	72	70	66
Transportation	22	24	39	45	42	40
Decorative	4	5	6	6	6	6
Marine flotation	11	14	16	13	12	14
Packaging	44	40	34	25	20	16
Miscellaneous	29	22	31	26	31	35

Source: Mobay

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